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PRELIMINARY EVALUATION OF TWO DICHOTIC LISTENING TASKS AS PREDICTORS OF PERFORMANCE IN NAVAL AVIATION UNDERGRADUATE PILOT TRAINING

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SUMMARY PAGE

THE PROBLEM

Attrition in undergraduate naval aviator training continues to be a costly problem. The successful conjunction of aviator skill definition and skill assessment will result in an improved prediction of an individual's chances of completing flight training and, consequently, reduce attrition and associated costs.

Aircraft pilots must divide their attention among a wide range of auditory inputs. Dichotic listening tasks (DLTs) have been utilized to assess selective attention performance and to predict the probability of success of aviation candidates in flight training programs. A preliminary evaluation has been conducted of two dichotic listening tasks on a subject population about to enter the Naval Aviation Undergraduate Pilot Training Program. This report presents the results of that evaluation, describes the statistical properties of the two DLTs, and presents estimates of their utility as predictors of human performance in Naval Aviation Undergraduate Pilot Training.

FINDINGS

Results indicate that both DLTs are reliable test vehicles and are unrelated to present selection tests. One DLT was significantly related to the successful completion of Naval Aviation Undergraduate Pilot Training.

RECOMMENDATIONS

Research should be initiated to investigate the behavioral constructs being measured by the DLTs. Is selective attention, auditory vigilance, motivation, or speech intelligibility being measured? In addition, a comparison of DLTs utilizing both natural and synthetic speech should be undertaken to determine the effect of vocal quality on DLT performance.

ACKNOWLEDGMENT

The technical assistance of Peter Collyer in preparing dichotic listening tapes is gratefully acknowledged.

INTRODUCTION

The term dichotic listening describes an auditory task in which both ears receive signals, but each ear receives a different signal from an independent channel. This task is contrasted to a diotic listening situation in which the signals are related, or only occasionally dissimilar. Since the early studies of Kimura on cerebral dominance (8,9), dichotic auditory stimulation has been utilized in a variety of clinical and research environments. A representative sample of its applications would include: cerebral dominance determination (7-9), clinical neurological testing (1,2,7,8), speech and language perception (7,8,12,13), language learning (12,13), memory (1,2,12,13), and selective attention (3,4,6,11).

Recognizing that naval aviation personnel (aviators, flight officers, and aircrewmen) often divide their attention among a relatively wide range of auditory and/or visual inputs, Gopher and Kahneman (4) proposed the application of a dichotic listening test to predict the probability of the success of aviation candidates in the Israeli Air Force Flight Training Program. Gopher and Kahneman presented a series of different Hebrew verbs and digits to each of the two ears of their subjects, with each series preceded by an auditory cue designating the ear to which attention was to be paid. Resulting performance accounted for additional variance associated with success in the Israeli Flight Training Program. The reliability of the test was not reported.

Pew, Rollins, Adams, and Gray (11) adapted a portion of the Gopher and Kahneman procedure as part of a selection battery for the U. S. Air Force. Their results were not so promising as those of Gopher and Kahneman, indicating a lesser degree of correspondence between performance on their dichotic listening test and success in the United States Air Force Flight Training Program.

Initial results reported by Gopher and Kahneman and subsequent extensive conversations between Dr. Gopher and the present investigators provided the impetus for the current study, the purpose of which was to develop a dichotic listening task (DLT) for predicting flight training performance in the United States Navy.

This report describes the properties of two DLTs, presents the initial results of their evaluation on a student aviator population, and discusses their potential as predictors of flight performance in Naval Aviation Undergraduate Pilot Training.

PROCEDURE

DESCRIPTION

The DLTs consist of the dichotic presentation of letter-digit strings. The listener is instructed to maintain attention to one ear while ignoring the other ear and to record on an answer sheet the digits presented to the designated ear in the sequence of their occurrence. The test apparatus

consists of a dual-channel tape recorder and headphones as the means of delivery of the selective attention tasks to subjects.

The use of letter text rather than Hebrew verbs, the use of "Left" and "Right" vocal channel "attend" commands presented stereophonically (rather than tones presented monaurally to the "attend" ear), and the use of computer generated speech for standardization purposes (rather than a female voice) represent departures from the Israeli DLT. An additional departure was the requirement for written, rather than oral, responses by the subjects.

Each DLT trial consists of two parts, labeled Part 1 and Part 2 (see Figure 1). The Part 1 task consists of a mix of letters and digits delivered to each ear. Digits are never presented simultaneously to the two ears, and no digit is repeated in either sequence. However, there are simultaneous presentations of identical or dissimilar letters, or a letter to one ear and a digit to the opposite ear. Part 2 of each trial consists of the simultaneous presentation of two letters to each ear followed by a string of four successive digits. Again, no digit is repeated to either ear. Both Part 1 and Part 2 of each trial are preceded by a "Right" or "Left" vocal channel attend command. The digit and text materials are presented at the rate of one letter or digit per 0.9 second. The DLTs represent speeded tasks to the extent that each trial must be performed within the time of its auditory presentation. A single trial (including pause time) is 26.8 seconds long.

PART 1																
	Left ear	R	8	N	S	M	Y	2	G	B	7	F	L	6	R	L	5
"Right" (Vocal Channel "Attend" Command)																
	Right ear	Y	L	3	S	R	4	F	Z	9	X	F	0	F	N	1	L
PART 2																
	Left ear	B	F	4	3	7	9									
"Left" (Vocal Channel "Attend" Command)																
	Right ear	G	L	1	5	6	2									

Figure 1

DLT TRIAL EXAMPLE

Preliminary research suggested that an initial DLT lacked a sufficient ceiling of difficulty. A number of attempts to increase the level of difficulty were tried, unsuccessfully. Finally, it was demonstrated that incorporating irrelevant background material (digits recorded in reverse) to each channel at a sound pressure level equal to the relevant test material significantly increased the difficulty for a small sample of Naval Aviation Officer Candidates (5). The initial DLT and the DLT containing background material were subsequently designated the Clear DLT and the Background DLT,

the only difference between the two being the added background material. A Votrax* synthetic speech system was utilized to generate the auditory speech sounds of the two DLTs.

The two DLTs consist of a total of 36 trials for both the Clear and Background DLTs. One hundred eighty correct responses are possible for Part 1, and 144 correct responses are possible for Part 2. Instructions for the Clear DLT are presented in Appendix A.

SUBJECTS

Navy and Marine Student Naval Aviators (SNAs) awaiting entry into the undergraduate training program volunteered to serve as subjects. Ninety-four SNAs participated in the evaluation. Seventy subjects were Marine SNAs from the Marine Aviation Training Support Group at the Naval Air Station, Pensacola, Florida, and 24 subjects were Navy Ensigns from the Naval Aviation Schools Command at the Naval Air Station, Pensacola.

The Clear DLT subject population consisted of 12 Navy and 34 Marine SNAs, while the Background DLT subject population consisted of 12 Navy and 36 Marine SNAs.

All subjects eventually entered the Naval Aviation Undergraduate Pilot Training Program. Seventy-eight SNAs completed training while sixteen failed, representing an overall attrition rate of 17 percent. This is slightly lower than expected, since the FY79 attrition rate was calculated to be 20.6 percent (10). Of the 16 SNAs failing training, eight performed on the Clear DLT and eight performed on the Background DLT.

METHOD

Pairs of subjects were administered either the Clear or Background DLT at a comfortable listening level of 75 dB Lp (re: 20uN/m^2) and then immediately retested after a period of 10 minutes.

For each subject, U. S. Naval and Marine Aviation Selection Battery scores were also obtained. The Battery consists of the Aviation Qualification Test (AQT), the Mechanical Comprehension Test (MCT), the Spatial Apperception Test (SAT), and the Biographical Inventory (BI). All students had initially qualified on these tests before receiving orders to flight training. In addition, primary flight grades as well as academic grades were collected to serve as additional criteria for the evaluation of the DLTs in the Navy undergraduate flying training environment.

A series of statistical analyses was conducted to (a) obtain descriptive statistics and reliabilities for the two DLT measures, (b) determine the

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*Vocal Interface Division Model VS-6 Votrax Voice synthesis unit.

relationship of DLT measures to each other and to Naval Aviation Selection Tests, and (c) evaluate the DLTs as predictors of human performance in Naval Aviation Undergraduate Pilot Training.

Although five different scoring systems have been devised for the evaluation of the Clear and Background DLTs, this report provides results based on the simplest scoring system--a sequence-independent, correct-response system that does not differentiate error types*, is completely objective, and is simple to score. The scoring system results in three performance measures: Part 1 number correct, Part 2 number correct, and total number correct.

RESULTS

DESCRIPTIVE STATISTICS

Means and standard deviations for the initial and retest administrations of the Clear and Background DLTs are presented in Table I. Analysis of variance statistical treatments indicated that subject performance was significantly different (degrees of freedom = 1; F = 114) on the two DLTs, with the Background DLT being more difficult (see Appendix B). This result supports the earlier finding (5) that the addition of background material increases task difficulty.

Test-retest reliability estimates (Pearson r correlations) for the DLT measures are shown in Table II. Although subject performance is seen to improve on the retest of each DLT, the high correlations indicate that the relative performance of individuals remained almost identical. The relationships suggest that the two DLTs possess a reliability adequate for the purpose of performance measurement.

Tables III and IV contain the intercorrelations of subject performance for the initial and retest administrations of the Clear and Background DLTs. For both DLTs the correlations between Part 1 and Part 2 measures (.91 for the Clear DLT and .78 for the Background DLT) indicate each part may be measuring a similar ability. Retest correlations were .74 for the Clear DLT and .67 for the Background DLT.

RELATIONSHIP OF DLT SCORES TO SELECTION AND TRAINING MEASURES

No significant correlations were found between performance on the first and retest administrations of the two DLTs and subjects' scores on the Naval Aviation Selection Test Battery.

To determine the relationship of DLT performance to proficiency in Naval Aviation undergraduate training, primary flight and academic grades were

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*Gopher and Kahneman utilized a scoring system which differentiated among "omissions," "intrusions," and "other" error measures. Their best single predictor of flight performance was the total of Part 2 errors, utilizing a dichotomous pass/fail criterion.

Table I

Descriptive Statistics of the Clear and Background DLTs
(Retest Means and Standard Deviations are in Parentheses)

Data Performance Measures	Clear DLT (46 Subjects) $\bar{X}$	S.D.	Background DLT (48 Subjects) $\bar{X}$	S.D.
Part 1 correct	176.674 (178.130)	5.357 (2.953)	162.979 (168.875)	10.074 (6.428)
Part 2 correct	142.087 (142.739)	4.231 (2.989)	131.687 (136.833)	9.154 (6.653)
Total correct	318.761 (320.870)	9.398 (5.543)	294.667 (305.708)	18.154 (11.967)

Total DLT possible correct over 36 test trials is 324 (Part 1 = 180, Part 2 = 144)

Table II

Reliability Measures for the Clear and Background DLT

DLT Performance Measures	Test/Retest Correlations Clear DLT	Background DLT
Part 1 correct	.822	.775
Part 2 correct	.787	.776
Total correct	.879	.851

(All relationships are significant at the .01 level)

Table III

Intercorrelation of Clear DLT Measures
(Retest Correlations are in Parentheses)

DLT Measures		1	2	3
Part 1 correct	1	-		
Part 2 correct	2	.913 (.740)	-	
Total correct	3	.983 (.932)	.973 (.934)	-

(All relationships are significant at the .01 level)

Table IV

Intercorrelation of Background DLT Measures
(Retest Correlations are in Parentheses)

DLT Measures		1	2	3
Part 1 correct	1	-		
Part 2 correct	2	.783 (.674)	-	
Total correct	3	.949 (.912)	.938 (.918)	-

(All relationships are significant at the .01 level)

collected to serve as criteria in addition to the overall dichotomous pass/fail criterion. The correlations between these criteria, Naval Aviation Selection Tests, and DLT performance are provided in Table V for the Clear DLT and in Table VI for the Background DLT. Relationships for the pass/fail criterion are point-biserial correlation coefficients. Pearson product moment correlation coefficients relating primary flight and academic grades to DLT measures are also presented.

Relationships for the Clear DLT, shown in Table V, indicate that all retest measures were significantly related to the pass/fail criterion ($p < .05$). No selection test score was significantly related to the pass/fail criterion, and no Clear DLT performance measure was significantly related to primary flight or academic grades. The AQT was significantly related to academic grades and the FAR was significantly related to flight grades in primary training.

Background DLT relationships are depicted in Table VI. No DLT measure was significantly related to the pass/fail criterion. The Biographical Inventory (BI) and Flight Aptitude Rating (FAR) were significantly related to the pass/fail criterion with point-biserial correlations of .39 and .30, respectively ($p < .05$). The FAR represents a combined measure of MCT, SAT, and BI Test Performance. It seems obvious from the relationships of Table VI that the BI is the measure resulting in the significant relationship of the FAR with the pass/fail criterion.

No selection test or DLT measure was significantly related to primary flight or academic grades for the Background DLT subject population.

REGRESSION ANALYSES

Forward selection multiple regression analyses were conducted based on a pass/fail criterion. The regression utilized initial and retest Part 1 and Part 2 measures and the AQT/FAR as independent variables (six measures). Total DLT scores were specifically excluded. Primary academic and flight grades were excluded from the regression since these measures become available too late in training to serve as early performance predictors.

For the Clear DLT, the retest Part 2 measure came into the equation first, followed by the initial test Part 1 score. Analysis of variance and t-test results shown in Table VII indicate that the measures made a significant contribution to the regression (a multiple R of .60), accounting for slightly more than 35 percent of the variance associated with the criterion ($p < .01$).

Appendix C contains the results of a forward selection multiple regression analysis with the AQT and FAR forced into the regression in first and second place. The results indicate that the identical respective DLT measures continue to make a significant and unique variance contribution to the regression beyond that provided by the selection tests.

Table V

Relationship of Clear DLT and Naval Aviation Selection Test Measures to Naval Aviation Undergraduate Pilot Training Performance

Measure	Pass/Fail (46 Subjects) rpbi	Primary Flight Grades (40 Subj.) r	Primary Academic Grades (40 Subj.) r
DLT			
Part 1 Correct	.208	-.141	.034
Part 2 Correct	.267	-.186	-.109
Total Correct	.239	-.171	-.034
Part 1 Correct Retest	.292*	.170	.035
Part 2 Correct Retest	.497**	-.018	.197
Total Correct Retest	.424**	.114	.121
Selection Tests			
MCT	-.083		
SAT	-.103		
BI	-.062		
AQT	-.142	.068	.400*
FAR	-.090	.370*	.248

Significance Levels	rpbi	r
	.05 = .291*	.05 = .312*
	.01 = .376**	.01 = .403**

Table VI

Relationship Of Background DLT and Naval Aviation Selection Test Measures to Naval Aviation Undergraduate Pilot Training Performance

Measure	Pass/Fail (48 Subjects) rpbi	Primary Flight Grades (42 Subj.) r	Primary Academic Grades (42 Subj.) r
DLT			
Part 1 Correct	.260	.010	.237
Part 2 Correct	.082	-.137	.180
Total Correct	.186	-.113	.222
Part 1 Correct Retest	.174	.072	.144
Part 2 Correct Retest	.073	-.131	.269
Total Correct Retest	.134	-.113	.229
Selection Tests			
MCT	.096		
SAT	.091		
BI	.388**		
AQT	.069	-.091	.225
FAR	.299*	.178	-.001

Significance Levels	rpbi	r
	.05 = .285*	.05 = .304*
	.01 = .368**	.01 = .393**

For the Background DLT, only the FAR made a significant contribution to the regression equation (R = .30) accounting for almost 9 percent of the variance associated with the pass/fail criterion ($p < .05$). Analysis of variance and t-test results are presented in Table VIII.

CONCLUSIONS

This preliminary evaluation of the Clear and Background DLTs indicates that both are reliable tasks with test-retest relationships in the .80 range. Relatively high correlations between Part 1 and Part 2 measures suggest both are measuring similar abilities.

No significant relationships were found between DLT performance measures and Naval Aviation Selection Test scores. A significant relationship was found between subject performance on the Clear DLT and criteria in the Naval Aviation Undergraduate Training Program. All retest performance measures for the Clear DLT were significantly related to the pass/fail training criterion ($p < .05$). No Naval Aviation Selection Test was significantly related to the pass/fail criterion for the Clear DLT subject population. No Background DLT measure was significantly related to the pass/fail criterion. Two Naval Aviation Selection Test Measures were, however, related to the pass/fail criterion for the Background DLT subject population: the BI ($p < .01$) and the FAR ($p < .05$).

Multiple regression analyses were performed for both the Clear and Background DLT subject populations. For the Clear DLT group, two measures, retest Part 2 and initial test Part 1, resulted in a multiple R of .60, accounting for 35 percent of the variance associated with the pass/fail criterion ($p < .01$).

For the Background DLT group, only the FAR made a significant contribution to the regression (R = .30), accounting for almost 9 percent of the variance associated with the pass/fail criterion ($p < .05$).

A forward selection multiple regression analysis which forced the AQT and FAR into the regression first, indicated that the Clear DLT measures (Retest Part 2 and Initial Test Part 1) contributed significant and unique variance to the regression beyond that provided by the selection tests.

RECOMMENDATIONS

While this evaluation of two DLTs indicates that a retest of the Clear DLT may be predictive of performance in the Naval Aviation Undergraduate Pilot Training Program, the evaluation raises several important questions. One question relates to the quality of the Votrax synthetic speech and its effect on DLT performance. A comparison of DLTs utilizing both "natural" and "synthetic" speech should be undertaken to determine the effect of vocal quality on DLT performance. An additional question which should be investigated relates to the behavioral construct being measured by the DLTs. Is selective attention, auditory vigilance, motivation, or speech intelligibility being measured? Administration of DLTs and other known test measures

Table VII

Clear DLT Multiple Regressions - Analysis of Variance, Coefficients, and t Values

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
TOTAL	45	6.609		
REG	2	2.343	1.171	11.809
RESID	43	4.266	0.099	

R-SQUARE = .0354 R = .595** (Significance level .01 = .430)

	COEFFICIENTS	STD ERROR	t VALUE
Constant	-9.341		
Initial Test Part 1	-0.039	0.015	-2.673
Retest Part 2	0.120	0.026	4.555

Table VIII

Background DLT Multiple Regressions - Analysis of Variance, Coefficients, and t Values

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
TOTAL	47	6.667		
REG	1	0.596	0.596	4.516
RESID	46	6.071	0.132	

R-SQUARE = 0.089 R = .299* (Significance level .05 = .282)

	COEFFICIENTS	STD ERROR	t VALUE
Constant	0.377		
FAR	0.065	0.031	2.125

to a suitable subject population, followed by the application of an appropriate factor analysis statistical procedure, should provide information concerning this question.

Subsequent to this investigation, two student naval aviators having previous experience as air traffic controllers pointed out similarities between the DLTs and air traffic controller tasks. For this reason, it is recommended that consideration be given to the evaluation of DLTs as potential predictors of air traffic controller performance.

Naval aviation primary flight instructors, after independent performance on a DLT and a psychomotor task* at Whiting Field, Florida, suggested that a combination of the two tasks in a dual mode would come very close to duplicating aviator performance requirements (i.e., aircraft control utilizing a combination of psychomotor/spatial skills and communication in a noisy environment to accomplish a multitude of mission tasks). It is recommended that research be conducted to determine if dual performance on a DLT and a psychomotor task accounts for additional variance in the prediction of performance in undergraduate flight training beyond that provided by either task in a singular mode.

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*A description of the psychomotor test device may be found in McGrevey, D. G. and Valentine, L. D., Validating two aircrew psychomotor tests. AFHRL-TR-74-4. Lackland AFB, Texas: Personnel Research Division, 1974.

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APPENDIX A

DICHOTIC LISTENING TEST (CLEAR) PROTOCOL

(Direct subjects to have a seat)

SAY: "The Dichotic Listening Test consists of a series of letters and digits which are presented to each ear through headphones. During the test, your task will be to concentrate your attention on the letters and digits you hear in a particular ear and to record only the digits heard in that series. The ear you must concentrate on is called the 'target ear' and will be clearly identified 'right' or 'left' before each series begins."

"Now, to better familiarize yourself with the test, put on your headphones and listen to a practice trial. Listen for the command 'right' or 'left'. Then, listen for the digits interspersed among the letters coming through that particular ear. The tape will begin momentarily."

(Have subjects put headphones on with red tag on right ear. Start recorder and proceed through practice trial number 1.)

SAY: "The 'right' or 'left' command that you heard at the onset of each series identified the ear you would have concentrated on during an actual test trial. Did you hear the digits embedded in the string of letters?"

"Now look at your Practice Answer Sheet. Each trial is divided into two parts labeled Part 1 and Part 2. Each is preceded by a 'left' or 'right' command. There are five digits embedded in Part 1 of each trial, and four digits embedded in Part 2. You are to record the digits you hear through the target ear in the blocks provided."

"Mark your answers horizontally across the answer sheet."

If you should fill all of your answer blocks, but hear another digit in the target ear, write the digit at the end of the blocks for Part 1 or Part 2, whichever is appropriate." (Point to the Dichotic Listening Test task trial diagram - Trial #1 - while saying this.)

"Okay, you will now actually do practice trials 1 and 2." (Point to crib sheet to subject's front.) "Remember to write only the digits you hear through the target ear in the answer blocks. The digits are zero through nine. 0 is not a zero. Repeat, 0 is not a zero." (PAUSE)

"Okay, try the first two practice trials. Afterward, we will discuss any problems you may have."

(Start recorder and put earphones on so that you can monitor.) Observe subject's performance on the two practice trials. If a subject is incorrectly filling out his answer sheet, stop the tape and take corrective action. Back up the tape and go through the two practice trials again, if this occurs. At the end of the two practice trials, stop the recorder and review subject's performance.

THEN SAY: "Now, I want you to complete the next four practice trials. After these are completed, immediately go to the next answer sheet. You will receive 36 test trials. Answer each set of 12 test trials on the answer sheets provided." (PAUSE) "Are there any questions? Okay, we will start the test now. The test will take approximately twenty minutes to complete."

"Stand by."

APPENDIX B

I. Comparison of performance of two subject populations on the first administration of the Clear and Background DLTs. Results (A) indicate that a significant difference in performance occurred on the two tests. In addition, results (B) indicate that a significant difference in performance occurred for both groups on Parts 1 and 2 of the DLTs.

ANALYSIS OF VARIANCE (WEIGHTED SQUARES OF MEANS)

Overall Performance Part 1, Part 2

SOURCE	DF	SS	MS	F	SIG LEVEL
A-DLT Tasks	1	6818.147	6818.147	113.666	0.000***
B-Part 1,2, Correct	1	50971.833	50971.833	849.757	0.000***
INT	1	2.715	2.715	9.945	1.000
ERROR	184	11037.052	59.984		

II. Comparison of performance of the two subject populations on the retest administration of the Clear and Background DLTs. Results are similar to I above.

ANALYSIS OF VARIANCE (WEIGHTED SQUARES OF MEANS)

Overall Performance Part 1, Part 2

SOURCE	DF	SS	MS	F	SIG LEVEL
A-DLT Tasks	1	2707.091	2707.091	101.186	0.000***
B-Part 1,2, Correct	1	52438.482	53438.482	1997.437	0.000***
INT	1	2.770	2.770	0.104	1.000
ERROR	184	4922.649	26.754		

APPENDIX C

Clear DLT Forward Selection Multiple Regression, Analysis of Variance, Coefficients, and t Values

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
TOTAL	45	6.609		
REG	4	2.426	0.606	5.946
RESID	41	4.182	0.102	

R-SQUARE = 0.367 R = .606** (Significance Level .01 = .501)

	COEFFICIENTS	STD ERROR	t VALUE
Constant	-10.144		
AQT	0.005	0.006	0.812
FAR	-0.019	0.026	-0.723
INITIAL TEST PART 1	-0.041	0.016	-2.633
RETEST PART 2	0.126	0.029	4.406

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Aircraft pilots must divide their attention among a wide range of auditory inputs. Dichotic listening tasks (DLTs) have been proposed to assess selective attention performance and to predict the probability of success of aviation candidates in flight training programs. A preliminary evaluation has been conducted of two dichotic listening tasks on a subject population about to enter the Naval Aviation Undergraduate Pilot Training Program. This report presents the results of that evaluation, describes the statistical properties

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of the two DLTs, and presents estimates of their utility as predictors of human performance in Naval Aviation Undergraduate Pilot Training.

Results indicate that both DLTs are reliable and are unrelated to present selection tests. One DLT was significantly related to the successful completion of Naval Aviation Undergraduate Pilot Training.

Future research should investigate the behavioral constructs being measured by the DLTs. Is selective attention, auditory vigilance, motivation,or speech intelligibility being measured? In addition, a comparison of DLTs utilizing both natural and synthetic speech should be undertaken to determine the effect of vocal quality on DLT performance.